Pueblo Ridge Restoration Project

Silviculture Report

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For:
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Introduction

The Pueblo Ridge Restoration Project (PRRP) is located within an area with insect and disease threats that impact forest health and increase the risk of wildland fire. There is a need to reduce the stocking levels to improve forest health, improve structural and species heterogeneity as well as reduce the surface and ladder fuels and canopy densities to improve fire resiliency.

The Carson National Forest (CNF) and communities in Taos Canyon are concerned about wildfire risk to private residents and infrastructure adjacent to National Forest System Lands, especially in light of the wildfires that have affected southwestern communities in recent years. The CNF is especially concerned with the area east of the Town of Taos in the Wildland Urban Interface (WUI) along the heavily trafficked Highway 64 corridor in Taos Canyon. Existing and potential hazardous fuels accumulations near and adjacent to residences in Taos Canyon and the Taos Pueblo create safety concerns for fire fighters, residents, and visitors, and the potential degradation of resource values.

The PRRP is designed to better protect personal and public property and resources, create a landscape (i.e., ecological conditions) that will improve the resilience of vegetation in response to wildland fire, and encourage the return of low and moderate-intensity fire as a natural process in the ecosystem. This project is considered a priority project for the Camino Real Ranger District and the Carson National Forest.

This specialist report will focus on the effects of different management strategies to achieve the desired future condition. The management strategies analyzed can be described as:

1) Alternative 1, the Proposed Action, amends the current Forest Plan, Land and Resource Management Plan (LRMP), to allow for mechanical treatments on slopes greater than 40 percent and implementing the revised Mexican Spotted Owl Recovery Plan.

2) Alternative 2 would treat the project area using current LRMP standards.

The effects of these different management alternatives will be analyzed and quantified using measurable indicators. Measurement indicators for effects will be directly related to and based upon: 1) issues identified during the project scoping period and 2) LRMP Standards and Guidelines for vegetation that are applicable to the proposed action.

Vegetation treatments in the proposed action are any combination of:

1) Variable density thinning.

2) Cutting of conifers that are overtopping and/or encroaching upon existing aspen clones.

3) Pruning of live and dead tree limbs to a prescribed height in fuelbreaks.

4) Treatment of existing and activity fuels using a combination of but not limited to:

    a. Mastication

    b. Hand piling of fuels and pile burning

    c. Prescribed fire

    d. Biomass removal

Relevant Laws, Regulations, and Policy

Regulatory Framework

Land and Resource Management Plan

The 1986 Carson National Forest Land and Resource Management Plan (Forest Plan) identifies forest-wide desired conditions and management direction. Management highlights from the Forest Plan particularly applicable to the Pueblo Ridge Restoration Project are outlined below and form the foundation for the purpose and need. Desired Conditions, Standards, and Guidelines from the Forest Plan are referenced below and will be applied throughout the project development and implementation.

Sustainable Forests

- "Maintain genetic and ecological diversity, and soil productivity" (SF-1).
- "Consider an area's position within the landscape in making all decisions. Develop diverse forest types and stand conditions, similar to that which occurred under prehistoric conditions" (SF-1).
- "A key to the sustainable forest is old growth. We will manage old growth to provide the following values: blueprint and sustainability; habitat diversity, recreation and aesthetics; opportunities for spiritual nourishment; high quality products" (SF-1).
- "Over time, we will have old growth well distributed throughout the Forest" (SF-1).

Relevant Standards and Guidelines for sustainable forests include Old Growth Standards and Guidelines regarding old, over story trees; treatments permissible; and providing for the distribution of old growth across the landscape(SF-6).

- "Treatments, such as prescribed fire or thinning, may be done in stands allocated to old growth if it will enhance old-growth characteristics. Stands not allocated to old growth, but which meet the old growth definition, may be harvested, where an interdisciplinary team determines it will contribute to management objectives for a diversity unit" (SF-6). If allocations of old growth occur at the project level, Forest Plan Objectives, Standards, and Guidelines will be met, particularly with respect to priority, undisturbed stands, and genetic interchange (SF-6 and 7).

Timber

- "Provide a non-declining sustained yield of timber consistent with land capabilities and other resource values" (Timber-1).
- "Improve site productivity through management" (Timber-1).
- "Provide green and dead firewood and other forest products on a sustained yield basis" (Timber-1).
- "Design timber resource activities with emphasis on benefits to wildlife, watershed, and recreation while maintaining productive timber stands and providing wood products" (Timber-1).

- "Protect the forest resources from destructive insects and diseases using integrated pest management" (Timber-1).

Fire

- "Fire, as a critical natural process, is integrated into activities on a landscape scale and across agency boundaries. Wildland fire will be used to protect, maintain, and enhance resources and, as closely as possible, be allowed to function in its natural ecological role" (Fire-1).

Relevant Standards and Guidelines for smoke management plans, burn permits, fuels, and fire will be applied (Fire-2).

The project will implement the Standards and Guidelines for timber from the Forest Plan, for silvicultural exams, vegetative manipulation and timber methods, thinning, diameter class distribution, and managing aspen (Timber-9). Standards and Guidelines will be used for integrated forest pest management, through integrated surveys, timber harvest, succession, and cutting prescriptions (Timber-10 and 11). Standards and Guidelines for timber sale preparation and administration include resource improvements, minimum cut volumes, firewood, bark beetle treatments, ground skidding and skyline yarding, 40% slope exceptions, treatment on unsuitable/ not appropriate lands, contract administration, integrated resource goals, firewood, and other standards and guidelines related to road construction and closure following harvest, treatments, and firewood slash cleanup (Timber-12 and 16).

Desired Condition

The overall goal of this restoration project is to improve the health and sustainability of forested conditions on and surrounding the project area. The primary objective for forest health is to increase resilience and resistance of forested stands. Increased resistance and resilience of these stands can be achieved by: a reduction in existing stand densities, a reduction in the amount of late seral species, and by the removal of overtopping and encroaching conifers from both aspen and hardwood stands as well as from riparian areas.

The Proposed Action would effectively reduce stand densities to levels less susceptible to insect and disease mortality than the current condition. The Proposed Action would also reverse the increasing late seral species dominance that has been the trend for the past century after the exclusion of fire on the landscape.

Secondary objectives of the project activities are to reduce surface, ladder, and canopy fuels and to break up contiguous vegetation. Prescribed fire would reduce surface fuels, where needed, using natural fire intervals after initial thinning treatments are completed. These improvements would, in turn, slow fire spread, reduce fire behavior, and provide fire managers the opportunity to reintroduce fire to the landscape. Prescribed burning would be conducted using a variety of ignition methods. Units would be burned with varying fire intensities resulting in mixed-severity fire effects and creating a mosaic of burned and unburned patches.

The Proposed Action would strategically break up the continuity and arrangement of existing and future hazardous fuels within the Wildland Urban Interface (WUI) in Taos Canyon (at-risk community) while maintaining the ecosystem structure and processes. Treatments would be designed to mitigate existing and future heavy fuel accumulations, reduce existing surface fuels,

and create canopy breaks and/or crown separation to minimize crown fire potential in the event of a wildfire.

Management Area

The proposed project includes the following nine Management Areas (MA), as shown in Table 1 below. Relevant Standards and Guidelines from the 1986 Forest Plan will be applied for each Management Area, unless amended by project-specific forest plan amendments.

Table 1. Management Area Direction for the Proposed Project Area

MA Number	Definition	Project Acres
1	Spruce under 40% slopes	888
3	Mixed conifer under 40%	4130
4	Ponderosa pine under 40%	1323
5	Mixed conifer and ponderosa pine over 40%	430
8	Pinyon-juniper	402
13	Oak	695
14	Riparian	972
15	Potential recreation site	2
16	Recreation site	868
Non FS	Non Forest System Lands	15
Total Acres		**9,724**

Topics and Issues Addressed in This Analysis

Purpose and Need

The purpose of the Pueblo Ridge Restoration Project is to improve the health and sustainability of forested conditions on and surrounding the project area by reducing hazardous fuels and moving vegetative conditions in the project area toward the desired conditions. The purpose and need for action is derived from the differences between existing conditions and desired conditions in the project area. The desired conditions are based on management direction in the Forest Plan and reference conditions for vegetation in the project area.

There is a need for:

- Reducing overall stand densities and moving stand conditions toward forest structures considered to be more typical of forest structure and composition under pre-settlement fire regimes;
- Improving tree vigor and stand resiliency;
- Reducing the risk for high intensity, stand-replacing wildfires;
- Reintroducing fire as a natural part of the ecosystem;
- Reducing fuel buildup to help prevent the spread of wildfire onto private property and into drainages leading into Taos Canyon and Taos Pueblo area;
- Providing forest products, such as firewood, for people living in Taos and the surrounding area, in order to meet their needs for forest and wood products, while protecting these resources for future generations;

- Improving habitat for wildlife and forage for range and wildlife; and
- Protecting project area watersheds and associated water quality.

Issues

The primary issues for Silviculture are expressed in the first two bullet statements above. In its current state of densification, the timber resource is at risk from insects; such as western pine beetle (*Dendroctonus brevicomis*), Douglas-fir beetle (*Dendroctonus psuedotsuga*) and spruce budworm (*Choristoneura freemani*), and stand replacing wildfires. There is a need to reduce stand densities to lessen the risk from these biotic and abiotic agents of disturbance. Analysis of the reduction of stand density will be discussed in this report.

Other Resource Concerns

Other resource concerns for the project area are expressed in the remaining six bullet statements above. These concerns focus on fire effects, wildlife habitat and water quality. These concerns are analyzed in other resource specialist reports. At this time no other issues or concerns: raised by the public or associated with laws, regulations or policies have been raised with respect to the timber resource.

Resource Indicators and Measures

Resource indicators are used to measure the effectiveness of actions taken to meet the purpose and need for a project. As previously stated, there is a need to reduce the density of timbered stands in the project area as well as to reduce the amount of later seral species across the project area. The need for this is to propel the existing forested structure and composition closer to historic norms.

This report evaluates treatment effectiveness using relative density as the resource indicator to measure stand density across the project area. Species dominance will be the resource indicator to measure treatment effectiveness in reducing the amount of later seral species across the project area. Table 2 describes these indicators and measures.

Table 2. Resource indicators and measures for assessing effects

Resource Element	Resource Indicator	Measure (Quantify if possible)	Used to address: P/N, or key issue?
Densification[1]	Overall Project Level Relative Density (RD)	Relative densities reduced from above 55 percent to within the acceptable range of 25 -55 percent.	Yes
Landscape is trending from Early to Late Seral Species	Overall Reduction the Species Dominance (SD) of Late vs. Early Seral Species	Basal Area (BA) percentage of early vs. late seral trees. An increase in the basal area percentage of early seral trees indicates fewer late seral trees.	Yes

Relative Density

The term "relative density" is a measure of the amount of tree vegetation on a unit of land area. Relative density measures "how full" a stand is. Another way to look at it would be how "free to grow" individual trees in a stand are based on the number, size and species of the rest of the trees in that stand. It can be

[1] Densification is the process of stands becoming denser over time due to the lack of natural disturbance.

the number of trees or the amount of basal area, or any of a variety of other parameters (Curtis 1970, Ernst and Knapp 1985).

For the purpose of this report analysis, relative density will be calculated by the following method. A stand's relative density can be expressed as the relationship between an existing stand density index (SDI) and a known maximum stand density index (SDImax) that could occur at the same average tree size (Helms 1998, Smith et al. 1997). In this way a stand's relative density (RD) can be calculated by the formula RD = SDI/SDImax.

Although SDI was originally described as a measurement of relative density in single-species, even-aged stands (Reineke 1933) and a SDImax was calculated for individual species: FVS; the growth model used for this report, calculates the weighted averages of SDI and SDImax for different species in a stand to compute the relative density of uneven-aged stands and multi-species stands (Keyser 2009).

Trees in a stand are not assumed to be competing when the relative density is 0 to 25 percent. At 25 percent density begins the onset of inter-tree competition. At 35 percent density the stand is at full site occupancy. Trees in stands with relative densities of 35-55 percent are assumed to be inter-competing but not experiencing competition-based mortality. Stands between 35 to 55 percent are growing at maximum volume production. Stands that have relative densities greater than or equal to 55 percent are assumed to be experiencing competition based mortality.

Species Dominance

Species dominance refers to the species that predominates in an ecological community, particularly when they are the most numerous or form the bulk of the biomass (Biology-online.org). Historically the dominant species in New Mexico forests were shade intolerant species (Moore et al. 2003). Selective logging of early seral species such as ponderosa pine also increases the dominance of later seral species over time. Over of the past century the dominance of these shade intolerant species has declined for a variety of reasons and shade tolerant species have increased in dominance. If stands dominated by early seral species do not experience some sort of disturbance that lowers existing stand densities, species that are more shade tolerant e.g. white fir (*Abies concolor*) and to some extent Douglas-fir (*Psuedotsuga menziesii*) tend to increase their dominance in stands over time (Moore et al 2013). Without some form of disturbance, whether man made or natural, early seral dominated forest tend to transition to late seral dominated forests (Taylor 2006).

Methodology

FSVeg Spatial Data Analyzer Modeling

FSVeg Spatial Data Analyzer (FSVegDA) is an analysis software package that integrates the FVS tree growth model and utilizes stand exam data from FSVeg (Field Sampled Vegetation) as well as spatial data from FSVeg Spatial in the analysis process. The Forest Vegetation Simulator (FVS) software variant used was; Central Rockies regional variant revised 01/08/18. The specific attributes for each of the measures were calculated from stand exam data taken in 2016 and 2017. These stand exams were completed using Forest Service Common Stand Exam protocols.

From the stand exam data several stand attributes were calculated for this report. Stand densities were calculated using a metric called "Relative Density". Species composition across the project area were determined using a metric called Species Dominance. This metric was calculated using percentage of basal area groups for both shade tolerant and intolerant species, measured pre- and post-treatment.

These attributes were modeled for the present, post-treatment, and into the future[2]. In addition to RD and Species Dominance, several other stand attributes associated with the fuels and wildlife resources, such as fuel loading, canopy cover, canopy base height, and canopy bulk density, were calculated and contribute the analyses for those resources. All outputs from the FSVeg Spatial Data Analyzer modelling are located in the project record.

Forest stands proposed for treatment were reviewed by Forest Service certified silviculturists for current insect and disease activity, species composition, stand density, and stand structure. Areas unsuitable for timber production were not considered for treatment related to timber production.

Information Sources

This analysis uses data collected during stand examinations on all proposed treatment units using Forest Service Region 3 protocols. Data and information was also collected during field visits by the project silviculturist and interdisciplinary team.

Sixteen of the stands modelled in this project did not receive stand exams. Stand exam information for these stands was derived using the FSVeg Spatial Data Analyzer nearest neighbor function.

Spatial and Temporal Context for Effects Analysis

Spatial and temporal boundaries set the limits for selecting the actions most likely to contribute to cumulative effects (FSH 1909.15, 15.2).

The temporal scale of the vegetation analysis is 20 years. Effects to vegetation can be modeled for longer time frames, but confidence in the modeled outputs decline substantially beyond 20 years primarily due to accumulation of assumptions and unknowns. Unknowns may include periods of drought, occurrences of insect outbreaks, fires, and natural regeneration densities. Because these are unknowns, assumptions must be made about whether they occur or not, their magnitude and severity if they occur, and other factors. As simulation lengths increase, the burden of assumptions and unknowns increase. The direct effects temporal scope for relative density and species dominance is immediately after treatment.

Direct/Indirect Effects Boundaries

The spatial boundaries for analyzing the direct and indirect effects to silviculture are the actual lands to be treated, because, for silviculture, the resource indicators and measures are static and only affect the exact footprint of the lands to be exchanged.

The temporal boundaries for analyzing the direct and indirect effects are before and after the treatments are concluded, because the direct and indirect temporal effects are immediate and final.

Cumulative Effects Boundaries

The spatial boundaries for analyzing the cumulative effects to silviculture are the actual lands treated, because, for silviculture, the resource indicators and measures are static and only affect the exact footprint of the lands to be treated.

[2] The future is defined as the 20-year planning horizon.

Affected Environment

Existing Condition

Current forest vegetation conditions are the result of various natural and human activities that have changed the historical condition of the forests and shaped the existing forest structure and composition. Timber harvest over the past century and a half has removed many of the larger shade-intolerant[3] species. This selective timber harvest combined with the suppression of fire has increased the amount of shade tolerant species[4] across the project area. As a consequence of this changed condition from the historical, forests are experiencing lowered resistance and resilience with respect to disturbance agents. Existing forest types in the project area and their percentage of the project area are displayed in Table 3

Table 3. Forest Cover Types within the Pueblo Ridge Project Analysis Area

Forest Cover Type	Area (acres)	Existing Relative Density (%)	Proportion of Analysis Area (%)
Mixed-Conifer[5]	3,855	67.1%	40%
Ponderosa Pine	2,776	70.6%	28%
Piñon/Juniper	2,368	82.1%	24%
Aspen	476	65.1%	5%
Engelmann Spruce-Subalpine fir	51	71.5%	<1
Gambel Oak	183	45.1%	2%
Private Ownership	86	N/A	1%
TOTALS / PERCENTAGES	9,795	71.3%[6]	100%

There has also been considerable deviation from the historic stand structure. Stand structure is increasingly homogenous. Openings once dominated by grasses and forbs have been encroached and overtopped with conifers. Stands that were more open and park-like, dominated by large diameter trees, now have smaller diameter trees with interlocking crowns with small diameter, later seral species creating "fuel ladders" from the forest floor into the canopies of the dominant trees. Many of the stands in the project area are undergoing species conversion from early seral species to later seral species. The early seral species trees tend to be the older and larger, dominant trees in most stands. These large trees are being "out-competed" by younger later seral species trees and the early seral, larger trees are not able to reproduce. Stands of aspen are being encroached and overtopped by conifers and they are slowly being removed from the landscape. In many areas, riparian vegetation is being encroached and overtopped by conifers.

[3] Shade intolerant species need direct or almost direct sunlight and do not regenerate in a stand that has heavy canopy cover. Existing shade intolerant individuals in the understory are either suppressed or killed. These species include: ponderosa pine, aspen and to some extent Douglas-fir.
[4] Shade tolerant species can survive in the shade of other trees. These species include: white fir, Engelmann spruce, sub alpine fir and to some extent Douglas-fir.
[5] Mixed conifer encompasses the Douglas-fir and white fir Forest types.
[6] Calculated excluding the 86 acres of Private Ownership.

In the forested portions of the project area, vegetation resource conditions have changed, primarily due to fire exclusion. Specifically, there are more trees (densification) and understory vegetation (shrubs, brush, and small diameter trees) than what historically occurred under a frequent, low-intensity fire regime (see Figure 4, which is an example of conifer densification from the mixed conifer forest type in the Lake Tahoe Basin of California).

Existing stand densities are considerably higher than historical levels when measured by relative density (RD). Stand structure is also altered with an increase in the number of multi-layered canopy stands and altered species composition due to fire exclusion. These elevated stand densities, altered structure and species composition, when combined with drought, can make the existing stands very susceptible to biotic disturbance agents like; bark beetles, spruce budworm, root diseases and dwarf mistletoes[7]. Walkthroughs of project area stands and stand exam data show that native insects such as bark beetles[8] and defoliators[9] are present at endemic levels. Although insects are at endemic levels, the project area is susceptible to insect outbreaks due to existing stand structure. Additionally these same observations indicate the presence of root diseases such as: Armillaria[10] *(Armillaria ostoyae)* and Annosus[11] *(Heterobasidion annosum*). Root diseases are more virulent in higher density stands (USDA FS 2005) as in the case across the project area.

In their current state, project area stand density, structure and species composition are susceptible to outbreaks of these native insects, root diseases and dwarf mistletoes if densities, structures and compositions are not altered to a less susceptible state.

[7] Mistletoes were observed in ponderosa pine, white fir and western juniper. Most observations were at the endemic level, however there are pockets of heavy infestation of dwarf mistletoes spread across the project area.
[8] Western pine beetle, Douglas-fir beetle
[9] Spruce budworm.
[10] Primary hosts are Douglas-fir and white fir and to a lesser extent in ponderosa pine.
[11] The P strain of Annosus primarily affects ponderosa pine. The S strain affects true firs and Douglas-fir to a lesser extent.

Existing Forest Types

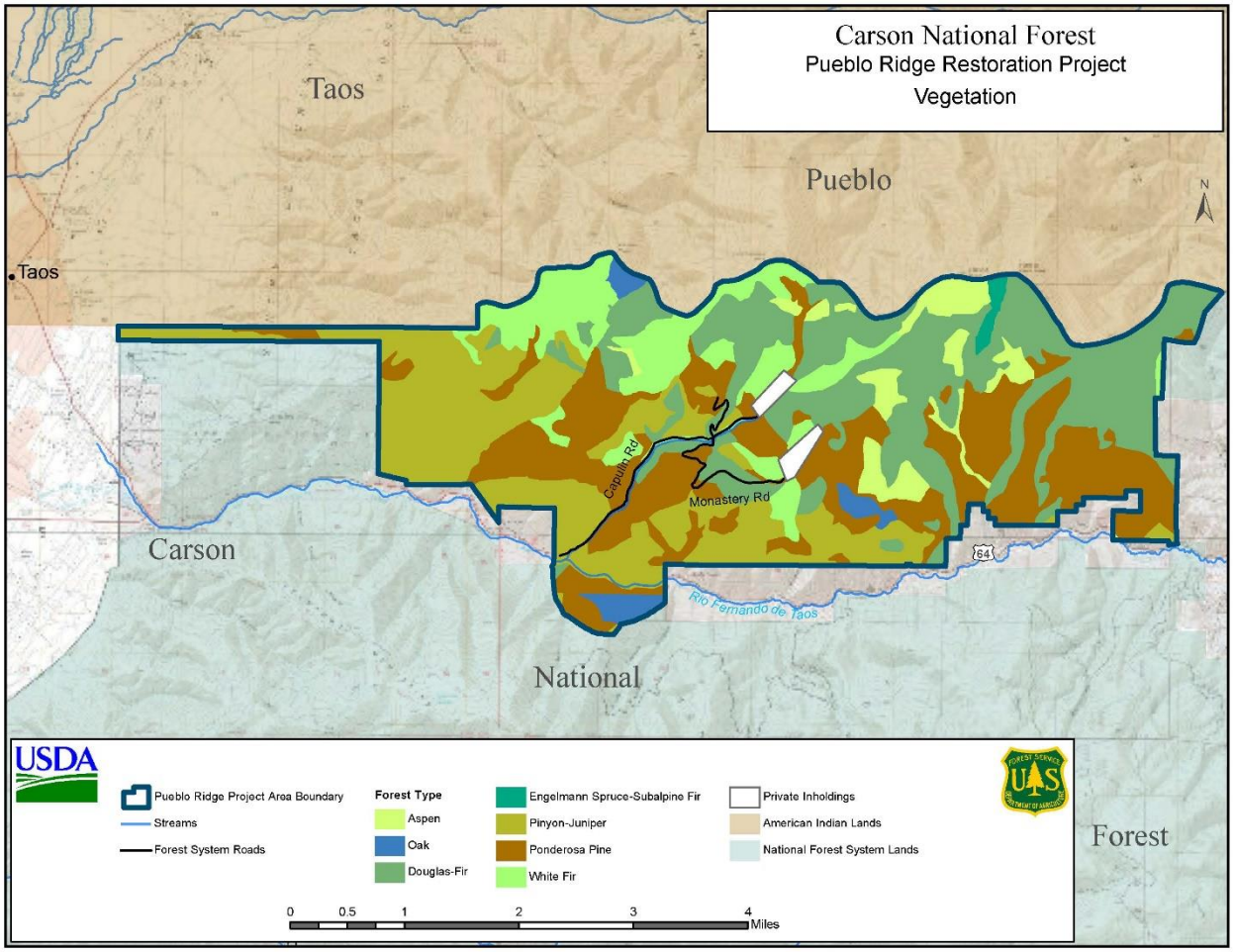

Figure 1. Existing Forest Types 2018

The spatial location and acres of the existing forest types of the Pueblo ridge project area are illustrated in Figure 1. Forest type is expressed by the existing dominant species in a stand as measured by its basal area in the stands.

Mixed Conifer

Mixed conifer is the most common forest type, making up approximately 40 percent (3,855 acres) of the analysis area. The mixed conifer cover type is comprised mainly of white fir and Douglas-fir with a mixture of other species depending on elevation and aspect throughout the analysis area. Mixed conifer occupies elevation ranging from 7,700-9,700 ft. Ponderosa pine is a seral species and may be found in the overstory and understory at the drier, lower elevations on southerly and southeasterly facing slopes. Blue spruce *(Picea pungens*), Engelmann spruce and other firs may be found at wetter and higher elevations on north-facing slopes. Quaking aspen clones can be found throughout all elevations with varying composition and structure.

Intensive stand exam data was collected for the mixed conifer acres for the Pueblo Ridge Restoration Project analysis area. Simulations were performed with the FSVeg Spatial Data Analyzer program that uses Forest Vegetation Simulator (FVS) as the internal program that models the stand dynamics of the

existing condition and proposed action. Existing average relative density for the mixed conifer forest type was estimated at 67.2 percent. When relative density in a stand exceeds 65 percent individual trees begin to experience density related mortality due to a lack of resources (Oliver and Uzoh 1997). In addition to density related mortality these stands can also be considered to be at high risk to insect and disease and wildfire because of stress.

Ponderosa pine

Ponderosa pine *(Pinus ponderosa)* is the second most common forest type, making up approximately 28% (2,776 acres) of the analysis area. The ponderosa pine cover type occupies elevations ranging from 7,000-9,500 ft. Ponderosa pine is a climax species at lower elevations where it generally grows with pinyon pine and Rocky Mountain juniper. At higher elevations, ponderosa pine is often seral and is replaced through time by shade tolerant conifers through forest succession. The overstories, in stands within the Pueblo Ridge Restoration Project analysis area, are either uneven-aged or even-aged depending on treatment and stand history. Stand composition varies throughout the analysis area with some stands comprised of scattered yellow pines (legacy trees) with small saw timber and pole-sized trees. Other stands consist of yellow pines with sapling and pole-sized trees where fire suppression has been in effect and there has been limited treatment activity. Pinyon pine are present in the understory of most stands at lower elevations and shade tolerant species such as white fir are present at higher elevations with minimal to no regeneration of ponderosa pine due to a high density of sapling and pole-sized trees.

Like the mixed conifer areas, ponderosa pine stands also received intensive stand exams. Existing average relative density for the ponderosa pine forest type was estimated at 70.6 percent. In this existing condition, the average ponderosa stand in the project area is at risk to agents of disturbance in its existing condition.

Pinyon-Juniper

Piñon/Juniper is the third most common cover type within the project area and makes up approximately 24 percent (2,368 acres) of the analysis area. The piñon/juniper cover type occupies elevations ranging from 7,000-8,400 ft. The most common species in this forest cover type include two-needle pinyonpine *(Pinus edulis)*, Rocky Mountain juniper *(Juniperus scopulorum)* and one-seed juniper *(Juniperus monosperma)*. The understory primarily consists of Gambel oak *(Quercus gambelii)*, mountain mahogany (*Cercocarpus montanus*), and big sagebrush *(Artemisia tridentate)* at varying degrees with little grass and forb cover. Regeneration primarily consists of pinyon pine and juniper seedlings and saplings. Most stands have an uneven-aged structure with three distinct size classes.

Like the mixed conifer and ponderosa pine areas, pinyon-juniper stands received intensive stand exams. Existing average relative density for the pinyon-juniper forest type was estimated at 82.1 percent. In terms of densification, pinyon-juniper stands are the most “crowded” stands in the project area. In this existing condition, the average pinyon-juniper stand in the project area is at risk to agents of disturbance in its existing condition.

Aspen

Aspen *(Populus tremuloides)* is the fourth most common cover type and makes up approximately 5% (475 acres) of the project area. Aspen occupies elevations ranging from 8,300-9,600 ft. within the analysis area. Aspen is a disturbance-driven species that relies on natural or human-caused disturbance for regeneration. Because of aggressive fire suppression and limited treatments over the last century, aspen composition within the analysis area and on the forest has diminished. Aspen is a “keystone species” that has many positive impacts to species such as Rocky Mountain Elk. Some stands are exclusively dominated by the aspen cover type with fir encroachment while other stands have not experienced any

forms of natural or human-caused disturbance leading to stands dominated by later seral and shade-tolerant conifer with some aspen inclusions or pockets in the overstory.

Spruce/fir

One 51 acre Engelmann spruce/subalpine fir stand (<1% of the project area) is located within the project area. Spruce/fir occupies elevations ranging from 8,600 – 10,300 ft. Historic conditions for the spruce/fir cover type likely resemble existing conditions, characterized by a high-severity fire regime that could have resulted in stand replacement for 66-100% of an area burned (USDA 2012). This fire regime would promote even-aged, closed-canopy stands with vertical continuity of live fuels between the understory and forest canopy due to less frequent fire and an abundance of shade-tolerant species regenerating in the understory.

Spruce/fir forest types received intensive stand exams. Existing average relative density for this forest type was estimated at 65.9 percent. In this existing condition, the spruce/fir stand in the project area is considered "within the zone of imminent mortality" and at risk to agents of disturbance in its existing condition.

Gambel oak

Gambel oak is found throughout the analysis area and makes up 2% (183 acres) of the project area. Gambel oak occupies elevations ranging from 7,100-8,400 ft. Gambel oak is found in pure stands with scattered, larger trees consisting of ponderosa pine and pinyon-juniper. Gambel oak is also a major component of the understory in conifer stands that are primarily comprised of ponderosa pine, but can also be found in stands containing Douglas-fir and white fir.

Gambel oak forest types received intensive stand exams. Existing average relative density for this forest type was estimated at 45.1 percent. In this existing condition, the average Gambel oak stand in the project area is still considered "free-to-grow" and only slightly at risk to agents of disturbance in its existing condition

Riparian Areas

As mentioned in the purpose and need for the project there is a need to protect project area watersheds and associated water quality. Currently riparian areas are experiencing encroachment by conifers that puts the integrity of the riparian areas at risk from wildfire.

Up to 10.5 miles (approximately 32 acres) of riparian restoration (conifer removal) within the project area and adjacent to the Rio Fernando in the La Sombra and Capulin Campgrounds would improve riparian habitat. Treatments may include conifer removal, ladder fuel reduction, and interconnected canopy reduction. The level of removal will depend on old growth, MSO habitat, or general forest guidance and directives.

Existing Old Growth

Old Growth was not identified as an issue during internal scoping of the project. Old growth is defined as containing; a number and minimum size of both seral and climax dominant trees that are multi-aged, multi-layered canopies, minimum number and specific size of snags, and adequate number of downed logs and coarse woody debris (Helms, 1998). The 1996 Forest Plan Amendment provides guidelines relevant to old growth and these guidelines have been followed during the planning phase of this project. Characteristics of old growth specified by the 1996 Forest Plan Amendment include number, age, size and length of downed logs, and the number of tree canopies. Appendix A identifies minimum structural attributes that must be considered to determine old growth on the Carson National Forest. The 1996

Forest Plan Amendment states that no less than 20% of each forested ecosystem management area must be allocated to old growth.

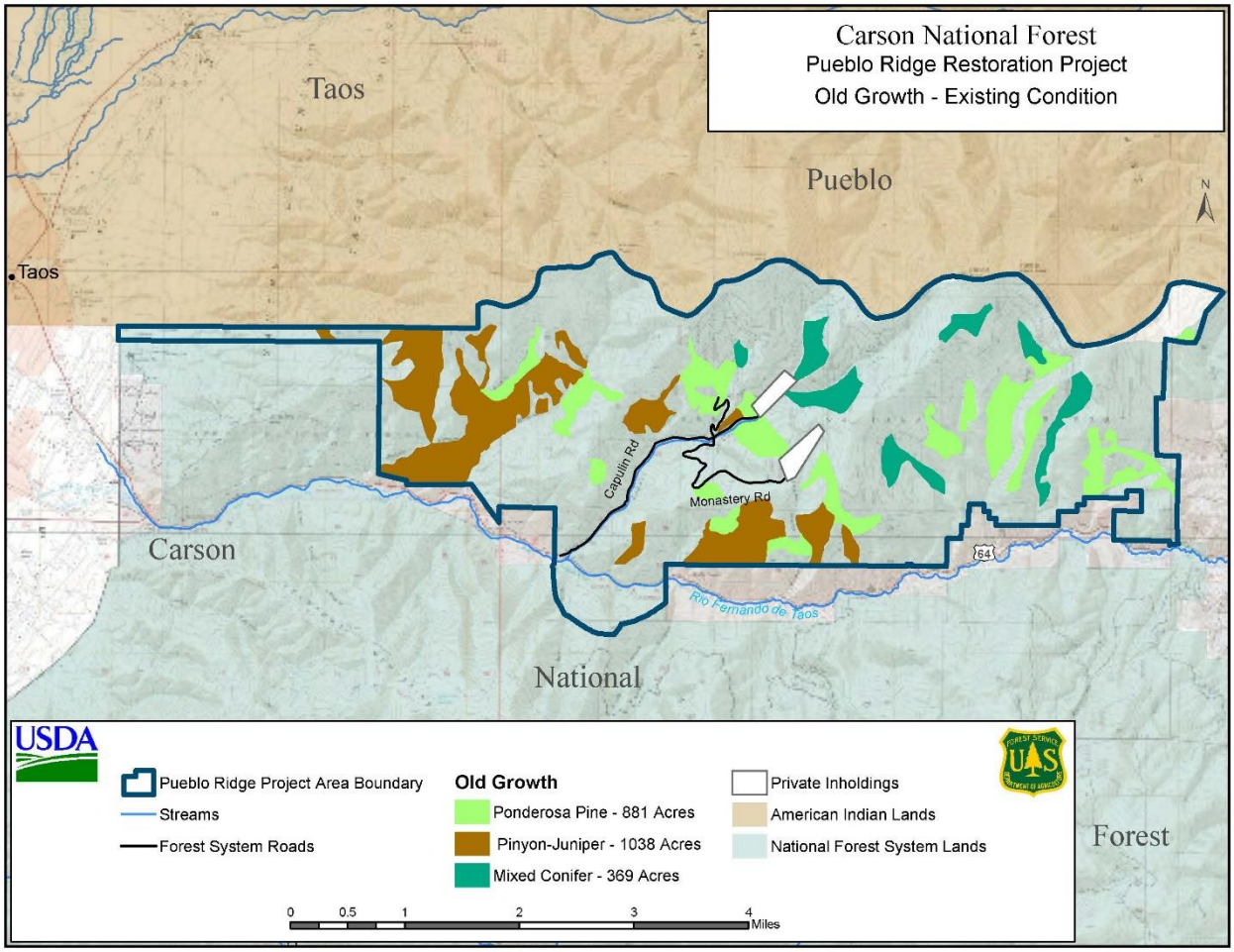

Figure 2. Existing old growth stands 2018

Stand exam data collected across 98% of the project area was used to identify stands with old growth characteristics. Analysis of stand exam data suggests that approximately 23.3 percent of the project area (2,288 acs.) meets or exceeds minimum old growth thresholds. Figure 2 displays stands that have been identified as old growth within the project area. The Forest Plan as amended mandates that there should be 20 percent old growth in five forest types[12]. As can be seen in Table 4, within the project area 43.7 percent of the Pinyon-Juniper stands, 31.7 percent of the ponderosa pine stands and 9.5 percent of the mixed conifer stands meet the requirement for old growth. None of either the aspen or Engelmann spruce-subalpine fir stands meet the requirements for old growth.

Table 4 illustrates the number of acres considered to be old growth by their forest type and total amount of old growth within the project area.

[12] Pinyon-Juniper, Ponderosa Pine, Aspen, Mixed –Conifer and Engelmann Spruce - Subalpine Fir.

Forest Cover Type	Acres of Old Growth	Percentage of their Forest Types
Mixed-Conifer	368	9.5%
Ponderosa Pine	880	31.7%
Pinyon-Juniper	1,036	43.7%
Aspen	0	0.0%
Engelmann Spruce-Subalpine fir	0	0.0%
Old growth totals within Project Area	2,288	23.3%

Table 4. Old Growth by Forest Cover Types within the Pueblo Ridge Project Analysis Area

Densification

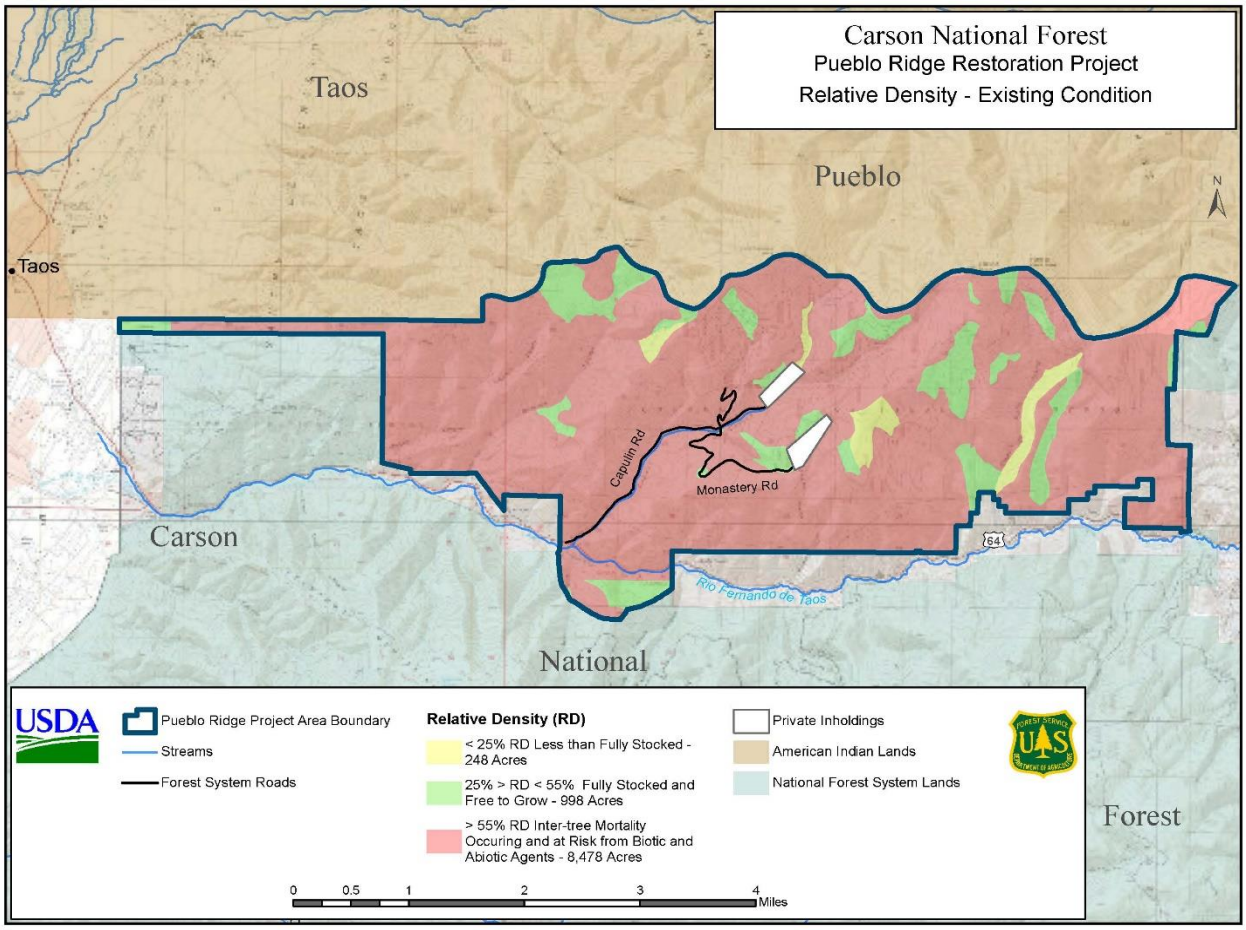

Figure 3. Existing Relative Density

Densification has been caused primarily by the suppression of wildfire and secondarily by selective logging in the twentieth century. The suppression of wildfire has prevented normal selective thinning of sapling and pole-sized trees in the forest understory, permitting continuous recruitment and increasing canopy cover by the shade-tolerant *s*pecies. With stand densification there is a significant increase in canopy cover (Goforth and Minnich 2008) and trees per acre. The overabundance of sapling and pole-

size trees which compete for limited soil moisture and nutrients is likely a factor causing decline of larger tree stem density.

Moore et al 2003 analyzed permanent plots in New Mexico and Arizona ponderosa pine stands. They found that tree numbers[13] had increased from an average of 77.4 trees per plot in 1903 to 519.1 trees per plot in 1999. As a result of densification the existing relative densities in the project area have increased dramatically. Figure 3 illustrates the existing relative densities across the project area.

Working in the Lake Tahoe Basin of California, Taylor, 2006 showed the concept of densification. **Error! Reference source not found.** shows Taylor's detailed image of the change in number of stems p er acre and average tree size from the pre-settlement era to today.

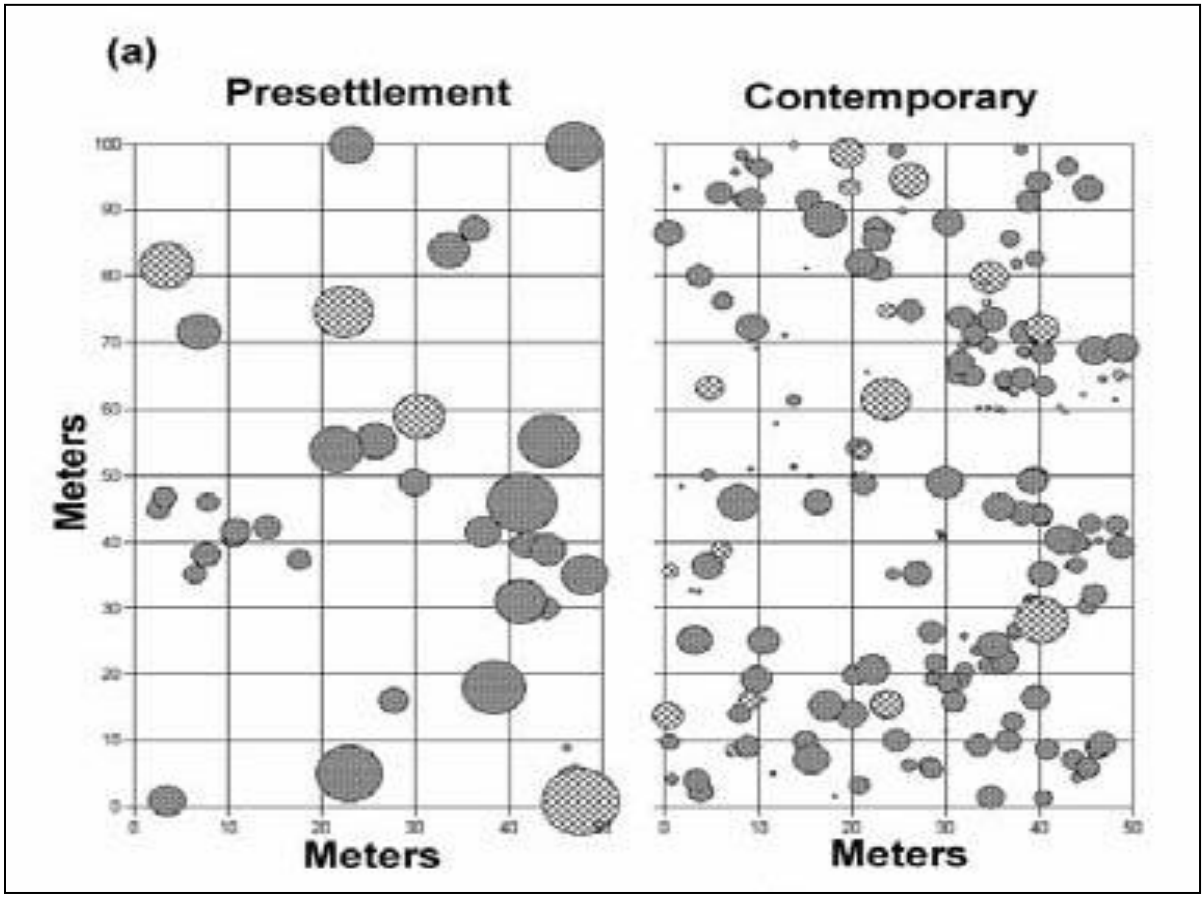

Figure 4. Example of Jeffrey pine - white fir stand densification before European settlement and today

Species Conversion

The amount of shade tolerant species is increasing in stands that historically have been dominated by shade intolerant species. The USDA Forest Service's 2016 Southwest Jemez Mountains Landscape Assessment identified the increasing dominance of shade tolerant, fire intolerant species in the mixed

[13] For trees greater than or equal to 4" in diameter at breast height.

conifer, ponderosa pine, aspen and pinyon-juniper forest types. These are the forest types that make up the vast majority of the project area.

Timber harvest over the past century and a half has removed many of the larger shade-intolerant[14] species. This selective timber harvest combined with the suppression of fire has increased the amount of shade tolerant species[15] across the project area.

The project areas forested stands, in their current state of densification combined with species conversion and drought are susceptible to insects, disease and stand replacing wildfires. Table 5 shows the existing condition of the resource indicators and measures.

Table 5. Resource indicators and measures for the existing condition

Resource Element	Resource Indicator (Quantify if possible)	Measure (Quantify if possible)	Existing Condition
Densification	Overall Project Level Relative Density (RD)	Relative densities reduced from above 55 percent to within the acceptable range of 25 -55 percent.	70.8%
Landscape is trending from Early to Late Seral Species	Overall Reduction the Species Dominance (SD) of Late vs. Early Seral Species	Basal Area (BA) percentage of early vs. late seral trees. An increase in the basal area percentage of early seral trees indicates fewer late seral trees.	71.3%[16]

Resource Indicator and Measure 1

Resource indicator 1 shows that the current relative density across the project area is at 70.8 percent. As previously discussed, at this elevated level, trees are competing with each other for finite resource such as water and nutrients. This competition significantly weakens the trees to the point where they lack the resources to successfully defend against insects and disease.

At this density level tree canopies are not separated, smaller trees in the understory act as fuel ladder and canopy base heights are low. All of these items create a significant risk to the existing stands from stand replacing wildfire events.

Resource Indicator and Measure 2

Resource indicator 2 illustrates that the existing species dominance of early seral species is at 71.3 percent. The remaining 28.7 percent of the total basal area of trees in the project area are in late seral species. An objective of the Proposed Action is to increase the percentage species dominance of early seral species.

Alternative 1 – Proposed Action

Alternative 1 amends the Forest Plan to allow for mechanical treatment on slopes greater than 40 percent and adopts new protocols for the degree to which Mexican Spotted Owl and Goshawk habitats can be modified to meet the desired condition.

[14] Shade intolerant species need direct or almost direct sunlight and do not regenerate in a stand that has heavy canopy cover. Existing shade intolerant individuals in the understory are either suppressed or killed. These species include: ponderosa pine, aspen and to some extent Douglas-fir.
[15] Shade tolerant species can survive in the shade of other trees. These species include: white fir, Engelmann spruce, sub alpine fir and to some extent Douglas-fir.
[16] This represents the percentage of project area BA that is in early seral species.

Forest Plan Amendments

Incorporate best available science for restoration in frequent-fire forests (Reynolds et al, 2013; Restoring Composition and Structure in Southwestern Frequent-Fire Forests, RMRS-GTR-310), including management direction in the revised Mexican Spotted Owl Recovery Plan, and clarifying language for northern goshawk management; and provide for steep slope treatments on slopes greater than 40% grade.

Proposed Silvicultural Treatments

In all prescriptions the largest and healthiest trees, including viable hardwoods, would be retained. Notwithstanding constraints due to issues with wildlife or old growth a sufficient number of trees would be removed to increase growth rates of the residual trees, increase stand structural diversity and space residual trees far enough apart to prevent crown fire type events from occurring. The density of the timbered stands would be reduced to make more water, nutrients, sunlight and growing space available to the remaining trees. Species composition would be shifted towards shade intolerant species.

Thinning of stands would occur in one of three ways; or in a combination of three ways. Dependent on existing conditions, trees would either be treated by: mechanical removal, mechanical mastication or by hand, or a combination of those three methods. Following these hand or mechanical treatments, multiple prescribed fire treatments would be used to reduce fuel loadings.

In all prescriptions the minimum number of snags and down woody material per acre would be retained (where available).

Mechanical Treatments

Mechanical treatment on up to 9,274 acres would utilize ground-based logging operations including: leveling feller bunchers, skidding, harvesters and forwarders, whole tree yarding and machine piling. Mechanical treatments would occur on up to 2,921 acres on slopes greater than 40% utilizing harvesting systems conducive to steep slope operations. Different mechanical treatments[17] are described below:

1. Old Growth Areas:

   Stands that are identified as being either High or Low quality Old Growth; by forest type, would be thinned from below down to minimum thresholds for the type of identified old growth they are (see Appendix A for definitions of High and Low quality Old Growth by Forest Type).

2. Mexican Spotted Owl Nesting/Roosting and Additional Nesting Roosting Habitat:

   Thin MSO Nest/Roost and Additional Nest/Roost to 120 BA leaving at least 30% of total residual BA in both the 12-18 and 18"+ DBH ranges.

3. Mexican Spotted Owl Recovery Habitat:

   Thin MSO Recovery Habitat to a residual canopy cover of 40 percent.

4. Aspen Areas:

[17] Various types of mechanical systems might to be used. e.g. 1) “Ponsee” which is a standard cut-to-length machine and fast forwarder type of tandem system that is tethered to an anchor point such as a tree or heavy piece of machinery or 2) a traditional skyline yarder.

Conifers within aspen stands and extending 150 feet beyond clones would be felled to encourage aspen suckering and increase clone size. Fuels remaining on site would be piled and burned and/or underburned to promote aspen regeneration. Silvicultural prescriptions may include weeding, liberation cuts, thin from above, and free thinning.

5. Conifer stands that are not in OG, MSO, aspen, oak or riparian areas:

   These areas would be treated by thinning to a residual 40 – 80 ft²/acre basal area with a target average of 60 ft²/acre BA in healthy stands.

6. Pinyon-Juniper Areas:

   Areas identified as pinyon-juniper would be treated by either removing special forest products[18] or fuelwood down to 40 – 60 ft²/acre basal area. Areas considered inappropriate for removal of treated material would be treated via mastication.

Table 6 provides detailed information for proposed treatment activities within and outside of fuelbreak treatment areas that are identified as MSO and/or old growth habitat. Prescriptions for proposed activities would adhere to management direction and minimum habitat requirements identified in the 2012 Mexican Spotted Owl Recovery Plan to maintain or reach minimum requirements for each designation for MSO.

Table 6. MSO and Old Growth Habitat Designations within Proposed Treatment Areas

MSO and Old-Growth Habitat Components in Proposed Treatment Areas		Potential Natural Vegetation Forest Types within Pueblo Ridge Project Area					
		Ponderosa Pine	Douglas-fir	White fir	Spruce-fir	Aspen	Pinyon-Juniper
Proposed Treatments in MSO Habitat Outside of Proposed Fuelbreaks	Recovery Habitat		1,049 acres				
	Nest/Roost Habitat		203 acres				
	Add Nest/Roost Habitat		249 acres				
	Nest/Roost and Old Growth Habitat		209 acres				
	Add Nest/Roost and Old Growth Habitat		151 acres				
Proposed Treatments in MSO Habitat Within Proposed Fuelbreaks	Recovery Habitat		729 acres	595 acres	26 acres	214 acres	
	Nest/Roost Habitat		119 acres	25 acres			
	Add Nest/Roost Habitat		274 acres				
	Nest/Roost and Old Growth Habitat		6 acres				
	Add Nest/Roost		5 acres				

[18] Fence posts or latillas

	and Old Growth Habitat						
Proposed Treatments in Old Growth Habitat	Outside of MSO Habitat	653 acres					869 acres

Fuels Treatment

Prescribed fire is being proposed throughout the project area and includes broadcast burning, jackpot burning and under burning to reduce surface, ladder, and canopy fuels and break up contiguous vegetation.

Prescribed fire could occur before or after initial thinning treatments are completed to afford fire managers flexibility with implementation. Multiple entries of prescribed fire may be needed to maintain post treatment conditions and mimic historic disturbance fire intervals in order to restore fire to a fire adapted ecosystem. Prescribed burning would be conducted using a variety of aerial or hand ignition methods. Units would be burned with varying fire intensities resulting in mixed-severity fire effects and creating a mosaic of burned and unburned patches of vegetation on the landscape.

In conifer areas identified as not appropriate for removal, mastication treatments (including boom-mounted masticators) and oak/brush removal/mastication would occur to reduce fuel loading. Chipping residual fuels and biomass in conifer areas is included as an option to reduce fuel loading prior to prescribed fire.

Hand and machine pile burning would also occur on 9,274 acres to reduce natural and activity fuel loading levels.

In fuelbreak areas, residual overstory trees in fuel reduction units may be pruned 8-10 feet high, where necessary, to raise tree canopy base heights. This would occur as needed to create a burnable fuel bed prior to prescribed fire.

Fuelwood harvesting activities on up to 6,803 acres would include dead and down fuel wood harvesting for 300 feet off of designated temporary roads and potential off-road travel for specific fuel wood areas for up to 10 years following thinning activities.

Hand Thinning Treatments

Commercial and personal use Christmas tree sales would occur in areas proposed for treatment that meet requirements for Christmas tree harvesting.

Riparian Treatments

Remove conifers that are encroaching and overtopping native riparian vegetation such as alders, aspen, narrowleaf cottonwood, and willow. Levels of thinning would be prescribed based on habitat components and management direction based on those habitat components, such as old growth and MSO habitat. Proposed treatments would be focused in areas that would potentially restore functioning condition and improve habitat. The desired condition would be a diversity of age and size classes of native riparian trees and shrubs with a diverse understory of native riparian herbaceous species. Large trees, snags, and down woody logs would be designated for retention to provide for habitat components, specifically in areas

that are not at risk to stand-replacing wildfire. Treatments may be performed mechanically with machinery such as a self-leveling feller buncher with a cutting and delimbing head or a mastication head. This machinery would allow for utilizing the arm (boom) to swing materials out of the riparian area without driving through, skidding, or dragging materials through the riparian zone. Other treatments would entail hand thinning, lopping and scattering materials, or piling and burning materials outside of the riparian zone. All treatment methods would follow best management practices

Identified Old Growth

Old growth areas would be thinned from below to reduce density, target later seral species and remove ladder fuels. The stands would be thinned down to the structural levels associated with the forest type and quality of old growth they are.

Table 7 provides information on potential silvicultural prescriptions that would be considered to meet the purpose and need of the project. Site-specific prescriptions would be developed during the implementation phase of this project to meet desired conditions while assuring habitat components and structural attributes are met.

Table 7. Potential Silvicultural Prescriptions by Forest Type, Habitat, and Old Growth Designations

Proposed Silvicultural Treatments by Forest Type and Habitat Components	**Estimated Treatment Acres by Potential Natural Vegetation Forest Type**
Uneven-aged Management in conifer areas outside of MSO habitat, old growth, aspen, oak, and riparian areas. Including but not limited to group selection, individual tree Selection, free thinning, and thin from Below Retention levels of 40 – 80 ft²/acre with an average basal area of 60 ft²/acre,	Ponderosa Pine - 1,834 acres White fir - 279 acres Pinyon-Juniper - 1,484 acres
Uneven-aged Management on acres proposed for fuelbreaks (Within MSO Recovery Habitat) Including, but not limited to thin from below, free thinning, individual tree selection, weeding, liberation cuts, and small patch cuts. Residual retention level of 40% canopy cover. Thin down to a residual basal area ranging from 30 – 120 ft²/acre with majority of average BA within 60ft²/acre. Retention of trees 18” DBH and larger where appropriate.	Douglas-fir – 729 acres White fir – 595 acres Spruce-fir – 26 acres Aspen – 214 acres
Uneven-aged Management in Aspen forest type. Including but not limited to weeding, liberation cuts, and thin from above Retention of live aspen and at least 3 – 6 large diameter conifers 18” DBH and larger for snag and down-woody materials recruitment	Aspen - 174 acres

Thin from Below in Old Growth Habitat Basal area and tree per acre retention requirements by forest type in Table 1 of Appendix A. For Ponderosa Pine: Manage for 20 trees per acre ranging from 14 – 18" DBH/DRC with a total basal area of 70 - 90 ft²/acre. For Pinyon-Juniper: Manage for 12 – 30 trees per acre ranging from 9 – 12" DBH/DRC with a total basal area of 6 – 24 ft²/acre.	Ponderosa pine - 653 acres Pinyon-Juniper - 869 acres
Uneven-aged Management in MSO Recovery Habitat. Including but not limited to Group Selection, Individual Tree Selection, Free Thinning, and Thin from Below Retention levels of 40% canopy cover. Retention of trees >24" DBH unless considered a threat to human life and property. Thin down to a residual basal area ranging from 35 – 120 ft²/acre with majority of average BA within 60 – 80 ft²/acre.	Douglas-fir – 1,049 acres
Uneven-aged Management in MSO Nest/Roost Habitat, Add Nest/Roost Habitat (Also includes acres that overlap with acres proposed for treatment with fuelbreak and old growth designation). Including but no limited to free thinning, individual tree selection, and thin from below. Minimum basal area retention level of 120 ft²/acre while retaining at least 30% of the basal area in both the 12 – 18" DBH and 18"+ DBH ranges.	Douglas-fir – 1,216 acres White fir – 25 acres

Environmental Consequences

Direct and Indirect Effects - Alternative 1

The most dramatic direct effect would be to reduce live tree density in most size classes. This would result in an increase in growing space, availability of water, nutrients, and sunlight to residual trees. The number of late seral tree species; especially in the smaller diameter classes would be reduced. The number of smaller trees that are considered ladder fuels would be decreased. Canopy spacing and bulk densities would be reduced.

Age and size class diversity of native deciduous trees and shrubs would be improved by removing non-native vegetation and encroaching conifers from riparian zones. Early-seral species distribution would increase and late-seral species densities would decrease following implementation, leading to improved habitat and riparian functioning condition with recruitment of hardwoods.

Treatments in the aspen forest type would reduce stand densities of encroaching shade-tolerant, late-seral conifers. Aspen regeneration would be triggered by implementing prescriptions tied to conifer removal and fuels treatment with prescribed fire. Wildlife habitat would be improved with the recruitment, establishment and maintenance of aspen populations while creating a patchy mosaic within the project area and disrupting aerial and surface fuel continuity.

Old growth, Mexican spotted owl and northern goshawk areas treated still have their same pre-treatment classifications. Aspen areas would be free of overtopping and encroaching conifers.

Indirectly, residual trees in treated areas would grow in an environment with reduced stress, resulting in decreased competition-related mortality. In addition, the treated areas would be more resistant to diseases and insects, especially bark beetles, due to increased tree vigor (Oliver and Uzoh, 1997), and would be less susceptible to wildfire mortality due to reduced fire behavior (see the Fuels Report and Chapter 2 of the EA).

Resource Indicator and Measure 1

Table 6 shows the change in resource indicators and measure post treatment if Alternative 1 is implemented.

Implementation of the Proposed Action would reduce the density of trees in the project area. Overall, relative density would be reduced from 70.8 percent to approximately 39.4 percent (see Figure 5). This impressive reduction in density takes the project area from a level where trees are dying from competition to a level where stands are still considered to be fully stocked and free to grow. Densities would remain higher in OG, MSO and Goshawk areas but would still be lower than existing condition densities.

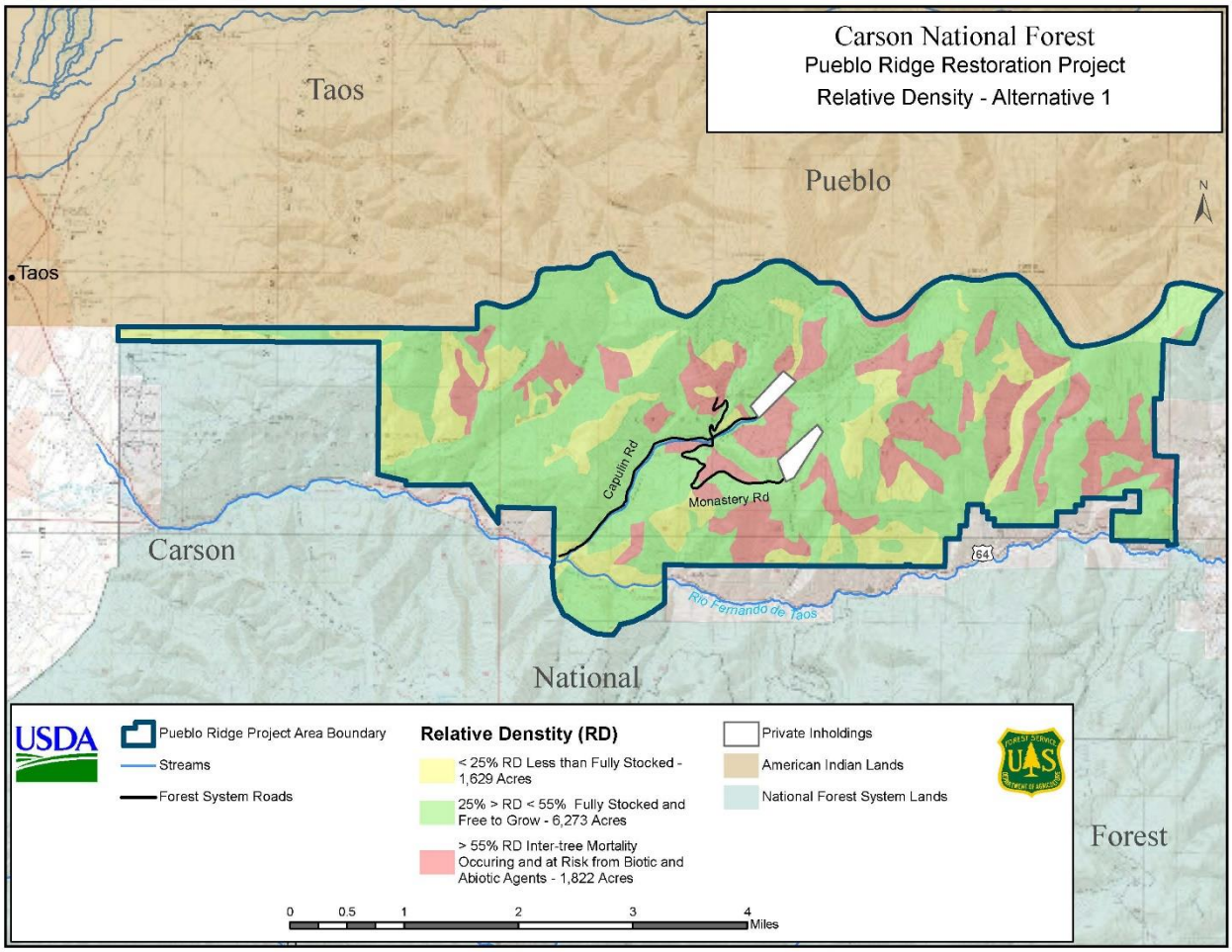

Figure 5. Post-treatment Residual Density Alt 1

Resource Indicator and Measure 2

Species dominance of early seral species would be increased after implementation. While not as dramatic a change as with density, early seral basal area would increase from approximately 71.3 percent to 79.0 percent if the proposed action is implemented.

Table 8. Resource indicators and measures for alternative 1

Resource Element	Resource Indicator (Quantify if possible)	Measure (Quantify if possible)	Condition in 2023 Post Treatment
Densification	Overall Project Level Relative Density (RD)	Relative densities reduced from above 55 percent to within the acceptable range of 25 -55 percent.	48.2%
Landscape is trending from Early to Late Seral Species	Overall Reduction the Species Dominance (SD) of Late vs. Early Seral Species	Basal Area (BA) percentage of early vs. late seral trees. An increase in the basal area percentage of early seral trees indicates fewer late seral trees.	79.0%[19]

[19] This represents the percentage of project area BA that is in early seral species.

Cumulative Effects – Alternative 1

Past, Present, and Reasonably Foreseeable Activities Relevant to Cumulative Effects Analysis

There are no cumulative effects from this project with respect to other past, present or reasonably foreseeable projects. As previously stated the analysis area for cumulative effects is the project area itself. The existing condition of the forested areas within the project area is a result of past projects. There are no present projects in the Project area. Within the footprint of the project areas there are no future projects planned.

The baseline year used for the existing condition in this analysis is 2017 when the stand exam data was collected. A list of past, present and future projects for the Pueblo Ridge project area was generated by Forest Service specialists and it can be found in the project record.

Project Design Features and Mitigation Measures for Alternative 1

Silviculture

- Leave trees and/or cut trees would be marked within the commercial forest product and personal use treatment units or may utilize a Designation-by-Description or Designation-by-Prescription approach.
- Slash at landings would be piled for future burning or masticated if the material cannot be used for biomass or fuelwood.
- Where available, a minimum of 20 percent of each forest type within the project area would be allocated for old growth management. Vegetation treatments and prescribed burning can occur in the allocated areas provided that 1) the treatment enhance the old growth characteristics and 2) does not reduce the allocated areas below the minimum thresholds set for both high quality or low quality old growth.
- VSS 6 (old and large) trees except in aspen stands would be retained unless they compromise forest health or pose a risk to public safety.

Alternative 2 – No Forest Plan Amendments

Please see Chapter 1 of the EA for a detailed description of Alternative 1.

Alternative 2 attempts to meet the need to reduce stand densities and increase the dominance of early seral species across the project area. Alternative 2, unlike Alternative 1, adopts no Forest Plan Amendments to achieve the desired condition.

Proposed Silvicultural Treatments

Are the same as Alternative 1 however, the individual prescriptions are listed below. Some are different.

Mechanical Treatments

Mechanical treatment on up to 9,274 acres would utilize ground-based logging operations including: feller buncher, skidding, and harvesters and forwarders, whole tree yarding and machine piling. Ground based mechanical treatments would not occur on slopes greater than 40 percent. Non-ground based mechanical treatments on slopes greater than 40 percent; such as a cable yarding system, could be

prescribed on up to 1,220 acres of the total mechanical treatment area. Different mechanical treatments are described below:

1. Old Growth Areas:

   OG less than 40 percent slope would be treated the same as in Alternative 1. On slopes that are greater than 40 percent, stands would be hand thinned from below up to 10 inch DBH. This activity fuel would be hand piled and burned prior to prescribed burning.

2. Mexican Spotted Owl Protected Areas (MSO habitat greater than 40 percent slope outside of Protected Activity Centers[20]):

   Use combinations of thinning trees less than 9 inches in diameter, mechanical fuel removal, and prescribed fire.

3. Mexican Spotted Owl Restricted Areas (MSO habitat less than 40 percent slope):

   At least 10 percent of MSO habitat identified as Restricted is at a minimum, post-treatment basal area of 170 BA. An additional 15 percent of the Restricted areas must have a minimum BA of 150 post-treatment.

4. Aspen Areas:

   Same as Alternative 1 except if slopes are steeper than 40 percent. Areas greater than 40 percent slope will be hand treated with the activity hand slash piled and burned prior to prescribed burning. Non-ground based mechanical treatments on slopes greater than 40 percent; such as a cable yarding system, could be prescribed

5. Conifer stands that are not in OG, MSO, aspen, oak or riparian areas:

   Same as Alternative 1 in the areas that are less than 40 percent slopes. Areas greater than 40 percent slope will be hand treated with the activity hand slash piled and burned prior to prescribed burning. Non-ground based mechanical treatments on slopes greater than 40 percent; such as a cable yarding system, could be prescribed

6. Pinyon-Juniper Areas:

   Same as Alternative 1 in areas less than 40 percent slope. Areas greater than 40 percent slope will be hand treated with the activity hand slash piled and burned prior to prescribed burning.

Fuels Treatment

Same as Alternative 1 in areas less than 40 percent slope. Areas greater than 40 percent slope will be hand treated with the activity hand slash piled and burned prior to prescribed burning.

Hand pile burning would also occur on up to 9,724 acres to reduce natural and activity fuel loading levels. Machine pile burning would also occur on up to 6,803 acres to reduce natural and activity fuel loading levels.

[20] There are no known PACS in the project area.

Hand Thinning Treatments

Commercial and personal use Christmas tree sales would occur in areas proposed for treatment that meet requirements for Christmas trees.

Identified Old Growth

With the exception of slope over 40 percent the proposed treatments are the same as Alternative 1. In Alternative 2, areas over 40 percent slope, treatments are limited to thinning from below[21] to nine inches DBH and handpile and burn activities fuels.

Riparian Treatments

With the exception of slope over 40 percent the proposed treatments are the same as Alternative 1. In Alternative 2, areas over 40 percent slope, treatments are limited to thinning from below to nine inches DBH and handpile and burn activities fuels.

Direct and Indirect Effects - Alternative 2

With respect to the Silvicultural resource, the direct and indirect effect of implementing this Alternative are similar to Alternative 1. The model predicts that implementation of Alternative 2 will improve forest conditions, but not as effectively as Alternative 1 will. (See Table 9).

[21] Biasing against late seral species and ladder fuels.

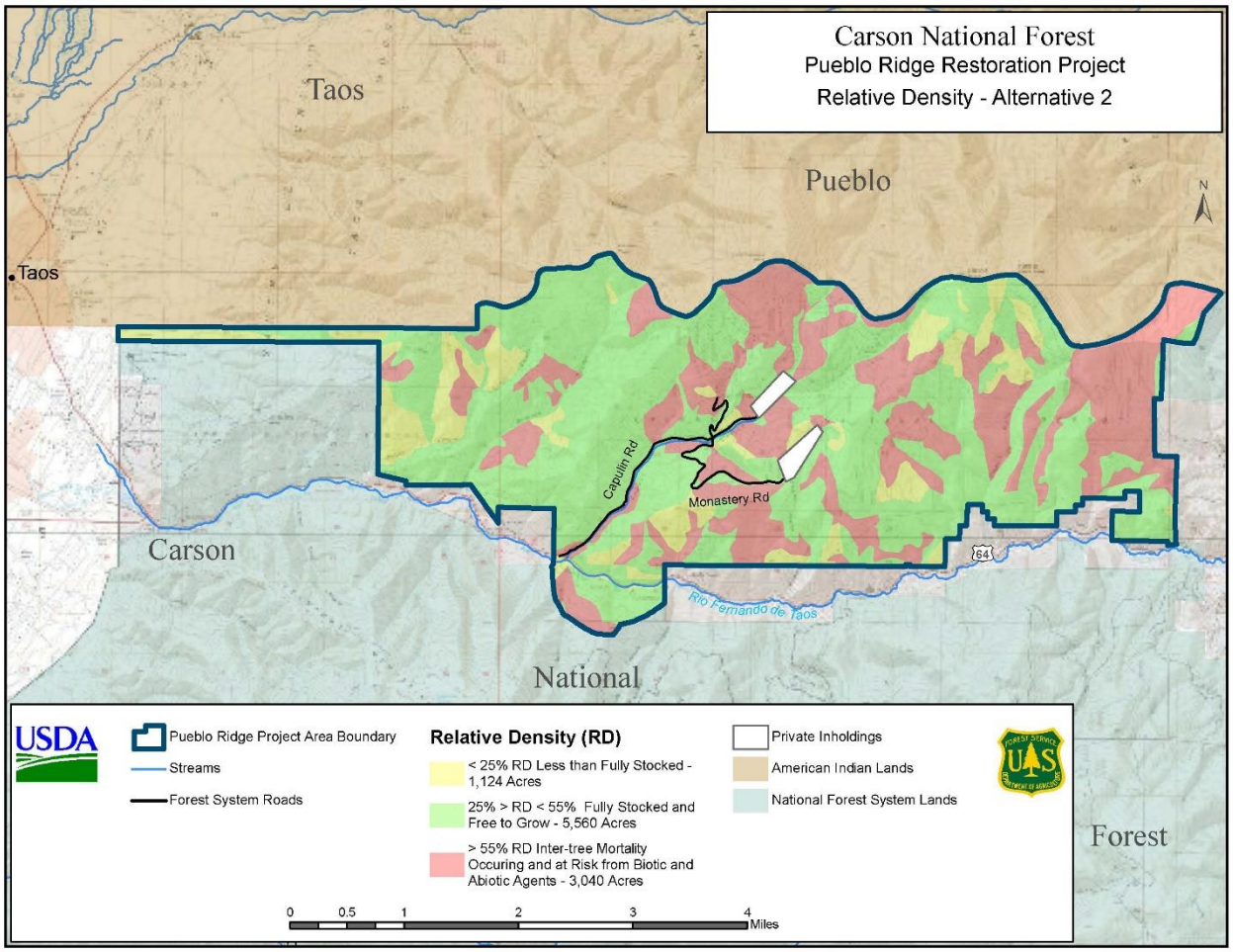

Figure 6. Post-treatment Residual Density Alt 2

Resource Indicator and Measure 1

Implementation of Alternative 2; as in Alternative 1, would reduce the density of trees in the project area. Coincidentally, relative density would be reduced from 70.8 percent to approximately 45.8 percent (see Figure 6). While Alternative 2 does create a reduction relative density it drops the average RD to somewhat less than the threshold where trees begin to die due to inter-tree competition and therefore is not as effective as Alternative 1.

Resource Indicator and Measure 2

Species dominance of early seral species will be increased after implementation. Table 9 illustrates the increase in stands dominated by early seral species.

While not as dramatic a change as in Alternative 1, early seral basal area will increase from approximately 71.3 percent to 77.7 percent if Alternative 2 is implemented.

Table 9. Resource indicators and measures for alternative 2

Resource Element	Resource Indicator (Quantify if possible)	Measure (Quantify if possible)	Alternative 2 Direct/Indirect Effects
Densification	Overall Project Level Relative Density (RD)	Relative densities reduced from above 55 percent to within the acceptable range of 25 -55 percent.	45.8%
Landscape is trending from Early to Late Seral Species	Overall Reduction the Species Dominance (SD) of Late vs. Early Seral Species	Basal Area (BA) percentage of early vs. late seral trees. An increase in the basal area percentage of early seral trees indicates fewer late seral trees.	77.7%

Cumulative Effects – Alternative 2

Past, Present, and Reasonably Foreseeable Activities Relevant to Cumulative Effects Analysis

The Cumulative effects for Alternative 2 are the same as Alternative 1.

Summary

There are key differences between the two alternatives considered in this analysis. The primary differences between Alternative 1 and Alternative 2 are:

1. Alternative 2 proposes to construct up to five miles of new, permanent road system to provide access to a portion of the project area that is inaccessible. Alternative 1 proposes no new permanent road construction by using cut-to-length and forwarding tandem systems to meet the purpose and need of the project.

2. Although the acres and proposed treatments are similar for both alternatives, outcomes for resource indicator measures differ due to applicability of proposed forest plan amendments, recovery plans, and guiding documents. Directions for Alternative 2 differ from those for Alternative 1 as they provide direction on following the current LRMP and the 1996 Amendment to the forest plan. The 1996 Amendment provides specific management direction for the Northern Goshawk and provides direction to follow the 1996 MSO recovery plan.

3. Alternative 1 follows guidance set forth by the 2012 Mexican Spotted Owl Recovery Plan while Alternative 2 follows guidance provided by the 1996 Mexican Spotted Owl Recovery Plan. Habitat designations, minimum basal area retention levels, and diameter limits for tree removal differ in both recovery plans.

4. Alternative 1 proposes a plan amendment to allow for mechanical operation on slopes greater than 40%. Alternative 1 would allow for the removal of thinned materials and biomass created from treatment activities on up to 2,921 acres using a forwarder. Through Alternative 2, those same acres would be hand thinned. A traditional skyline yarder could potentially be used through Alternative 2 to remove materials and biomass. Otherwise, materials and biomass would remain on-site and likely need to be treated with hand piling and burning activities.

As can be seen in Table 5, there is a significant difference in the reduction of relative density between the two alternatives. Alternative 1 reduces the relative density of the project area at a rate 9.5 percent higher than Alternative 2. Both alternatives effectively implement the purpose and need of reducing stand densities from the current level where trees are at risk from agents of disturbance and are dying due to inter-tree competition.

There is a small difference between implementing Alternative 1 vs. Alternative 2 with respect to the second purpose and need for the project: halting and reducing the ever increasing dominance of late seral species across the project area. This could be due to different prescriptions affecting different acres in both alternative as well as prescribed burning early in the spring season. As can be seen in Table 10, Alternative 1 is slightly more effective in reducing the amount of late seral species compared to Alternative 2.

The amount of acres considered to be both old growth and MSO habitat will not change from the existing condition following treatments. This is due to prescriptions[22] having thresholds that do not treat and remove forest structures below minimum thresholds for existing types of old growth and MSO habitat.

Implementation of Alternative 1 meets the project's purpose and need with respect to Forest resiliency from biotic agents of disturbance better than Alternative 2. As previously discussed relative density is reduced to well within the desired range of density.

Table 10. Summary comparison of how the alternatives address the purpose and need

Purpose and Need	Indicator/Measure	Alt 1	Alt 2
Need to reduce existing forested stand densities closer to historical levels.	Overall Project Level Relative Density (RD)	Trees are not competing with each other for resources. RD is 39.4% post-treatment. Alternative 1 reduces average stand density to a much lower level than Alternative 2.	Trees are not competing with each other for resources. RD is 45.8% post-treatment. Alternative 2 drops average stand density below the threshold for inter-tree mortality due to competition.
Need for existing stand species composition to be more like historical species composition	Overall Reduction in species dominance of Late vs. Early Seral Species (SD)	Early seral species dominance is increased to 79.0% of the total BA in the project area. This alternative reduces the level of late seral species at a slightly higher rate than Alt 2.	Early seral species dominance is increased to 77.7% of the total BA in the project area. This alternative reduces the level of late seral species at a slightly lower rate than Alt 1.

Degree to Which the Purpose and Need for Action is Met

As can be seen in Table 10, both alternatives meet the purpose and need of reducing stand density. Post treatment, in both alternatives the forested stands in the project area are free to grow. However, Alternative 1 is significantly more effective at reducing relative density than Alternative 2.

Table 10 shows that Alternative 1 is slightly better at meeting the purpose and need for reducing the dominance of later seral species than Alternative 2.

Both Alternatives meet the purpose and need of the project better than a strategy of "No-Action". Under a No-Action scenario the average stand density for the project area would rise from the current 70.8 percent existing relative densities to 80.3 percent at the end of the temporal analysis[23] (See table 11).

Additionally, both Alternatives are also better at increasing the dominance of early seral species until the end of the planning horizon. Under a strategy of No Action species dominance of early seral species would drop from the existing 71.3 percent to 75.8 percent which is a reduction of 4.5 percent in late seral

[22] Treatment prescriptions based on diameter limits and residual trees per acre, basal areas, etc.
[23] 20 years. 2038

species basal area from the existing condition. A No Action strategy would decrease the amount of later seral species, however, both Action Alternatives increase the amount of early seral species at the end of the planning horizon by a far greater amount (See table 11).

Table 11. Degree to which the Purpose and Need is met by Alternative at end of the planning horizon when compared to No Action.

Purpose and Need	Indicator/Measure	No Action Strategy	Alt 1	Alt 2
Need to reduce existing forested stand densities closer to historical levels.	Overall Project Level Relative Density (RD)	RD is predicted to be 80.3% at end of planning horizon up from the existing condition of 70.8 % relative density. Trees are competing with each other at extreme levels with higher levels of mortality.	RD is predicted to be 39.6% at the end of the planning horizon. Trees are not competing with each other for resources. Alternative 1 is more effective at the end of the planning horizon than a No Action Strategy or Alternative 2.	RD is predicted to be 45.8% at the end of the planning horizon. Trees are not competing with each other for resources. Alternative 2 is more effective at the end of the planning horizon than a No Action Strategy but less than Alternative 1.
Need for existing stand species composition to be more like historical species composition	Overall Reduction in species dominance of Late vs. Early Seral Species (SD)	Early seral species dominance is predicted to increase to 75.8% from the existing 71.3%. This strategy continues the trajectory of the existing stands' condition where later seral species dominance is increasing.	At the end of the planning horizon under Alternative 1, early seral species dominance is increased from the existing 71.3% to 80.6% Alternative 1 is much better than a No Action Strategy for decreasing the level of late seral species and is slightly better than Alternative 2.	At the end of the planning horizon under Alternative 2, early seral species dominance is increased from the existing 71.3% to 79.2% Alternative 1 is better than a No Action Strategy for decreasing the level of late seral species and is slightly worse than Alternative 1.

Compliance with LRMP and Other Relevant Laws, Regulations, Policies and Plans

Both alternatives 1 and 2 would comply with all the Forest Plan vegetation management standards as outlined on page **Error! Bookmark not defined.** of this report.

Other Relevant Mandatory Disclosures

There are no mandatory disclosures associated with the Silvicultural resource.

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Appendix A - Definitions of High and Low Quality Old Growth

Old growth is defined as containing; a number and minimum size of both seral and climax dominant trees that are multi-aged, multi-layered canopies, minimum number and specific size of snags, and adequate number of downed logs and coarse woody debris (Helms, 1998). The 1996 Forest Plan Amendment provides guidelines relevant to old growth and these guidelines have been followed during the planning phase of this project. Characteristics of old growth specified by the 1996 Forest Plan Amendment include number, age, size and length of downed logs, and the number of tree canopies. Old Growth, and the characteristics unique to the condition, is an important component of healthy, functioning ecosystems.
Old growth exists in all forest cover types, in blocks of all sizes, and on sites of varying quality.

The 1996 Record of Decision (ROD) Amendment of Forest plans established Standards and Guidelines for the designation and allocation of old growth (USDA, 1996). Standards include the allocation of "no less than 20 percent of each forested ecosystem management area (EMA) to old growth" as depicted in Table 1, and that allocations will consist of landscape percentages meeting old growth conditions and not specific acres. Allocated areas will change over time across the landscape due to changing conditions or natural disturbances at variable scales.

Table 1. Minimum Criteria for the Structural Attributes Used to Determine Old-Growth.

Forest Cover Type	Piñon-Juniper		Interior Ponderosa Pine		Aspen	Mixed-Species Group		Engelmann Spruce Subalpine Fir	
Site Capability	Low	High	Low	High	All	Low	High	Low	High
Live Trees in Main Canopy:									
Trees/Acre	12	30	20	20	20	12	16	20	30
DBH/DRC	9"	12"	14"	18"	14"	18"	20"	10"	14"
Age (Years)	150	200	180	180	100	150	150	140/170	140/170
Dead Trees Standing									
Trees/Acre	0.5*	1	1	1	ND	2.5	2.5	3	4
Size DBH/DRC	9"	10"	14"	14"	10"	14"	16"	12"	16"
Height (Feet)	8'	10'	15'	25'	ND	20'	25'	20'	30'
Dead Trees Down									
Pieces/Acre	2	2**	2	2	ND	4	4	5	5
Size (Diameter)	9"	10"	12"	12"	ND	12"	12"	12"	12"
Length (Feet)	8'	10'	15'	15'	ND	16'	16'	16'	16'
Number of Tree Canopies	SS/MS	SS/MS	SS/MS	SS/MS	SS	SS/MS	SS/MS	SS/MS	SS/MS
Total BA, Square Feet/Acre	6	24	70	90	ND	80	100	120	140
Total Canopy Cover, Percent	20	35	40	50	50	50	60	60	70

Piñon-Pine: *Dead limbs help make up dead material deficit.
**Unless removed for firewood or fire burning activities.

Spruce-Fir: *In mixed corkbark fir and Engelmann spruce stands where Engelmann spruce is less than 50 percent composition in the stand.
**In mixed corkbark fir and Engelmann spruce stands where Engelmann spruce is 50 or more percent composition in the stand.

ND is not determined; SS is single-storied; and MS is multi-storied.